Ignition Voltage (starting voltage, striking voltage)

The minimum voltage which must be applied between the anode and cathode of a tube in order to initiate a glow discharge.

Burning Voltage (maintaining voltage)

The voltage between anode and cathode when a glow discharge has been established and the tube is passing current within its specified limits.

Regulation Voltage

The change in the burning voltage when the current is changed from the maximum to the minimum value.

Incremental Resistance

The slope of the burning voltage against burning current characteristic at some specified tube current.

Temperature Coefficient of Burning Voltage

The rate of change of burning voltage with tube ambient temperature for a fixed tube current.

Stability

The change in burning voltage with life caused by changes in tube characteristics. This excludes changes due to variations in tube current, temperature, etc.

Ignition Voltage

This is the voltage at which the discharge in a tube will be initiated. Normally the average tube will ignite at a voltage somewhat lower than the maximum figure quoted but the latter should always be available. Certain tubes are affected by ambient light, and in complete darkness some delay may occur between the application of the ignition voltage and the actual firing of the tube.

Burning Current

Except for a temporary overload during starting, the circuit values must be such that the current through a tube always falls within the maximum and minimum limits quoted in the data. Excessive current will lead to high heat dissipation with possible loss of stability while at very low current the tube may effectively become extinguished. At starting, a current of up to 2.5 times the maximum mean current may be drawn for a period of 10 seconds or less. This covers the period while thermionic valves in an equipment warm up and draw their normal current. This overload should not be applied at intervals of less than a few minutes.

For **reference tubes** a preferred operating current is also quoted. Whenever possible this current should be adopted and maintained constant since it represents an operating point which is both free from discontinuities in characteristics and also has a maximum stability over life. If the current is changed during life and then returned to its original value the high order of stability may be impaired.

Reversal of Polarity

Reference tubes and stabilisers should never be operated in such a way that they can draw reverse current. This can be met by ensuring that the maximum reverse voltage ever applied to a tube does not exceed 90% of the normal burning voltage.

Series and Parallel Operation

Where different types of stabilisers are connected in series care must be taken to ensure that the burning current falls within the permitted limits of all tubes. At first sight it would seem that a supply voltage must be available which is equal to the sum of all the individual ignition voltages of the several tubes; however, the supply voltage requirements for series operation will be eased by connecting a resistor network (to ensure successive striking of the tubes) across one or more of the tubes. These resistors should have values of the order of 200 kΩ.

Stabilisers should not be connected in parallel with each other because of the difficulty of ensuring equal current distribution.

Stabiliser Behaviour with an Alternating Component of Tube Current

In certain applications the current supplied to a stabiliser or reference tube consists of a predominantly direct current with a superimposed alternating component caused by rapid fluctuations in load, supply voltage ripple, etc.

Because of the finite internal impedance of a gas-filled discharge tube this alternating component may give rise to undesired coupling. In addition, the internal impedance of stabiliser tubes increases with increasing frequency.

In order to avoid coupling effects the stabiliser should be shunted by a capacitor whose value will be determined by the tube impedance that can be tolerated and by the impedance of the remainder of the circuit. However, the value of the capacitor should be made as small as possible in order to minimise the chance of relaxation oscillations and also to reduce the transient tube current at starting. Normally a capacitance of the order of 0.5μF is suitable.

SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES

GENERAL NOTES

These general notes include definitions and general test procedures. They should be read in conjunction with the data sheets for Special Quality Tubes. Where reference should be made to a specific note, this is indicated on the data sheet by an index number, e.g. Group Quality Level[7].

1. *Limiting Values.* The limiting values quoted on the data sheets are absolute ratings. Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any tube of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

   These values are chosen by the tube manufacturer to provide acceptable serviceability of the tube, taking no responsibility for equipment variations, environmental variations, and the effects of change in operating conditions due to variations in the characteristics of the tube under consideration, and of all other electron devices in the equipment.

   The equipment manufacturer should design so that initially and throughout life no absolute maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply variations, equipment control adjustment, load variations, signal variation, environmental conditions and variations in characteristics of the valve under consideration and of all other devices in the equipment.

   The life expectancy of a tube may be appreciably reduced if the maximum ratings are exceeded. Furthermore, in gas-filled tubes certain limiting values, such as the minimum voltage necessary for ignition must be met completely or the tube may show a total failure to operate at any time after installation.

   In the interests of reliability the bulb temperature should always be kept as low as possible.

2. *The A.Q.L.* (Acceptable quality level) is the limit below which the average level of defectives is controlled.

3. *Maximum and minimum values for the individuals* are the limits to which tubes are tested.

4. *Maximum and minimum for lot average* are the limits between which the average value of the characteristic of a lot or batch is controlled.

5. *Lot standard deviation* is the standard deviation of a lot or batch.

6. *Bogey value* is the target value.

7. *Group quality level.* This is the A.Q.L. over a whole group of tests.

   Sub-group quality level. The A.Q.L. over a number of tests which do not constitute a complete group.

8. *Glass envelope strain test.*

   (*A*) This test is carried out on a sampling basis and consists of completely submerging the tubes in boiling water at a temperature between 97 and 100°C for 15 seconds and then immediately plunging them in ice cold water for 5 seconds. The tubes are then examined for glass cracks.

   (*B*) This test is carried out on a sampling basis and consists of completely submerging the tubes in boiling water not less than 85°C for 15 seconds and then immediately plunging them in ice cold water not more than 5°C for 5 seconds. The tubes are then examined for glass cracks.

9. *Base strain test.* This test is carried out on a sampling basis and consists of forcing the pins of the tubes over specified cones and then completely submerging the tubes and cones in boiling water at a temperature between 97 and 100°C for 10 seconds. The tubes and cones are allowed to cool to room temperature before examining for glass cracks.

10. *Lead fragility test.*

    (*A*) This test is carried out on a sampling basis and consists of holding the tubes vertically and having a 1-lb weight freely suspended from the lead under test. The tubes are inclined slowly so as to bend the weighted lead through 45°, back to 45° in the other direction, back to 45° in the first direction and finally back to the vertical, the entire action taking place in one vertical plane. The tubes are examined for cracks and broken leads.

(*B*) This test is carried out on a sampling basis and consists of holding the tubes vertically and having a 1-lb weight freely suspended from the lead under test. The tubes are inclined slowly so as to bend the weighted lead through 90° and return it to the vertical, the entire action taking place in one vertical plane. This cycle is repeated for the number of times shown on the data sheet. The tubes are examined for broken leads.

11. This test is carried out on a sampling basis under the conditions detailed in the data.

12. *Shock test.* This test is carried out on a sampling basis and subjects the tubes to 5 blows of the specified acceleration in each of 4 directions.

13. *Inoperatives.* An inoperative is defined as a tube having an open or short circuit electrode, an air leak or a broken pin.